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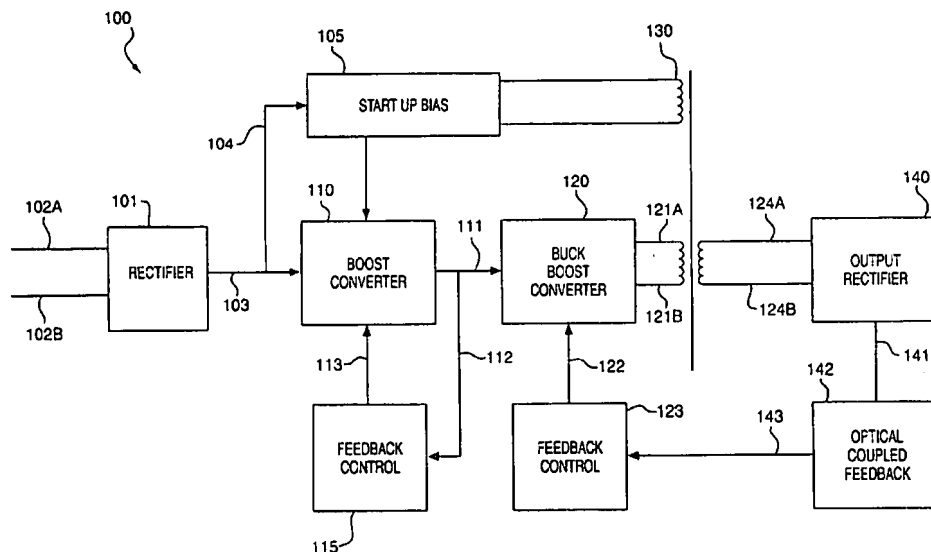
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(54) Title: UNIVERSAL INPUT TO DC OUTPUT CONVERSION CIRCUITRY



(57) Abstract: A circuit (100) supplying a DC output of a desired voltage from an input regardless of power received. In this circuit (100), a rectifier (101) converts an alternating current (AC) input to direct current (DC) or changes a DC input to a desired polarity. A boost converter (110) receives DC current having a first voltage from the rectifier (101) and outputs DC current having at least a minimal voltage. Finally, a buck boost converter (120) receives the DC current having the at least said minimal voltage and outputs DC having a desired voltage.



WO 01/76049 A2

**UNIVERSAL INPUT TO DC OUTPUT CONVERSION CIRCUITRY****Field of the Invention**

This invention relates to circuitry that provides a Direct Current (DC) of a constant voltage to a load. More particularly, this invention relates to circuitry that receives either Alternating Current (AC) and DC of varying voltages from a power source and outputs DC of a constant voltage. Still more particularly, this invention relates to a circuit that receives power from an AC or a DC source and provides DC of a constant voltage of a constant voltage to a signal conditioner in meter electronics of a Coriolis flowmeter.

**Problem**

It is a problem that different countries, even in different regions of countries, that electricity may be delivered in different manners and at different voltages. Some countries may provide DC electricity and other may provide AC electricity. The problem becomes exasperated when wiring in different facilities deliver electricity in different manners and voltages.

Manufacturers of electronic components that are shipped throughout the world are constantly looking for ways in which to provide electricity of a constant current and voltage to a load. The ability to provide a constant current and voltage to a load would save substantial development and manufacture time as one power supply would be used for the component.

One device in which this is a particular problem is a Coriolis flowmeter. A Coriolis mass flowmeter measures mass flow and other information of materials flowing through a conduit in the flowmeter. Exemplary Coriolis flowmeters are disclosed in U.S. Pat. Nos. 4,109,524 of August 29, 1978, 4,491,025 of January 1, 1985, and Re. 31,450 of February 11, 1982, all to J. E. Smith et al. These flowmeters have one or more conduits of straight or curved configuration. Each conduit configuration in a Coriolis mass flowmeter has a set of natural vibration modes, which may be of a simple bending, torsional or coupled type. Each conduit is driven to oscillate at resonance in one of these natural modes. Material flows into the flowmeter from a connected pipeline on the inlet side of the flowmeter, is directed through the conduit or conduits, and exits the flowmeter through the outlet side of the flowmeter. The natural vibration modes of the vibrating, material filled system are defined in part by the combined mass of the conduits and the material flowing within the conduits.

When there is no flow through the flowmeter, all points along the conduit oscillate due to an applied driver force with identical phase or small initial fixed phase offset which can be corrected. As material begins to flow, Coriolis forces cause each point along the conduit to have a different phase. The phase on the inlet side of the conduit lags the driver, while the phase on the outlet side of the conduit leads the driver. Pick-off sensors on the conduit(s) produce sinusoidal signals representative of the motion of the conduit(s). Signals output from the pick-off sensors are processed to determine the phase difference between the pick-off sensors. The phase difference between two pick-off sensor signals is proportional to the mass flow rate of material through the conduit(s).

Meter electronics in the Coriolis flowmeter provide a drive signal to a driver as well as processing signals from the pick-off sensors to determine mass flow rates and other properties of a material. Manufacturers of Coriolis flowmeters such as Micro Motion Inc. of Boulder, Colorado USA sell Coriolis flowmeter to various countries throughout the world and desire a circuit for providing power to the meter electronics that is a DC current and has a constant voltage regardless of power source.

#### **Solution**

The above and other problems are solved and an advance in the art by power supply circuit that outputs a DC of a constant voltage from an input of either AC or DC at any voltage. One advantage of this invention is that only one power supply circuit must be placed in manufactured component no matter where the component is being used. This decreases the development time for a component as well as reducing the manufacturing costs of the component.

In accordance with this invention, a circuit for supplying a DC output of a desired voltage from an input regardless of the power source includes the following components. A rectifier receives an input current and converts an alternating current (AC) input to direct current (DC) or changes a DC input to a desired polarity. A boost converter receives DC current from the rectifier and outputs current having at least a minimal voltage. The DC current received from the rectifier has an unknown voltage and the boost converter simply boosts the voltage to a minimal level if the current does not have that minimal voltage. A second boost converter called a buck boost convertor receives the DC current having at least the minimal voltage and outputs DC having a desired voltage.

The circuit may also include a transformer that provides a galvanic barrier between said buck booster and a load. The galvanic barrier prevents excess current, voltage, or power from being applied to the load. The circuit may also include an output rectifier that prevents excess current from being applied to the load. An  
5 opto-coupled feedback may be connected to the output rectifier. The opto-coupled feedback provides a signal to a buck boost feedback control that regulates current output from the buck-booster converter.

The circuit may also include control circuitry that maintains the at least minimal output voltage of current output by the boost converter. The circuit may also include  
10 start-up circuitry that regulates voltage applied to said control circuitry.

### **Description of the Drawings**

The above and other advantages of this invention are described in the detailed description and the following drawings:

FIG. 1 illustrates circuitry for a power supply in accordance with the present  
15 invention; and

FIG. 2 illustrates a Coriolis flowmeter that incorporates a circuit for a power supply operating in accordance with this invention.

### **Detailed description**

FIG. 1 illustrates a power supply circuit 100 in accordance with this invention.  
20 Power supply 100 may receive either AC or DC input current at any voltage up to a maximum voltage and output DC at a desired voltage. This allows the same power supply to be used to supply loads regardless of where in the world that the load is being sold.

Power supply has a rectifier 101 that receives input current over paths 102A  
25 and 102B. The input current may be either AC or DC and may have any voltage. Rectifier 101 is a conventional rectifier that converts an AC current to DC current and changes the polarity of a DC current if needed. A benefit of rectifier 101 is the DC may be applied in either polarity. A DC current having a proper polarity and same input voltage is applied by rectifier 101 to path 103.

30 Boost convertor 110 receives the DC current applied to path 103 and boosts the voltage of the DC current to at least a minimal value. Boost convertor 110 is a conventional booster. If the voltage of the DC current is greater than the minimal voltage, the DC current passes through boost convertor 110 unchanged.

DC output from boost convertor 110 is applied to path 111. Buck boost convertor receives DC applied to path 111. Buck boost convertor receives the DC and either boosts the DC to a desired voltage or limits the DC to a desired voltage. Buck boost convertor 120 may be a conventional SEPIC booster. DC with the desired  
5 voltage is then output over paths 121A and 121B.

A transformer 130 may be coupled to the output of buck booster convertor 120. The transformer 130 provides a galvanic barrier between the power supply 100 and a load (Not Shown). The galvanic barrier prevents excess current, voltage, or power from being applied to the load. This is critical when power supply 100 is providing DC  
10 to an intrinsically safe load which is a load that does not have sufficient energy to cause a spark or generate heat that could ignite a volatile material.

DC over transformer 130 is applied to paths 124A and 124B. DC on paths 124A and 124B may be applied to output rectifier/ filter 140 which prevents any excess current from being applied to the load (Not shown). DC current is then output  
15 from output rectifier/filter and applied to the load.

DC from output rectifier/filter 140 may also be applied to path 141. Optical coupled feedback 142 receives the DC from path 141, generates an optical signal indicating the DC, and transmits the signal to feedback control 123. Feedback control 123 is a conventional feedback loop circuit that regulates the DC voltage of buck boost  
20 convertor 120 via path 122. Feedback control 115 is a conventional feedback loop circuit that receives DC output from boost convertor 110 via path 112 and controls the voltage output via path 113.

Start-up bias circuitry 105 receives DC from rectifier 101. Start-up bias circuitry limits voltage and current applied to control circuitry 115 and 123. When power is  
25 initially applied start-up bias circuitry allows only a controlled amount of circuitry to be applied to control circuitry 115 and 123 to begin operations at the desired levels.

FIG. 2 illustrates a Coriolis flowmeter 200 that incorporates power supply 100 in accordance with the present invention into meter electronics 250. Coriolis flowmeter 200 includes a flowmeter assembly 210 and meter electronics 250. Meter  
30 electronics 250 are connected to a meter assembly 210 via leads 220 to provide for example, but not limited to, density, mass-flow-rate, volume-flow-rate, and totalized mass-flow rate information over a path 275. A Coriolis flowmeter structure is described although it should be apparent to those skilled in the art that the present

invention could be practiced in conjunction with any apparatus having loads require currents of alternating voltage.

5 A Coriolis flowmeter structure is described although it should be apparent to those skilled in the art that the present invention could be practiced in conjunction with any apparatus having a vibrating conduit to measure properties of material flowing through the conduit. A second example of such an apparatus is a vibrating tube densitometer which does not have the additional measurement capability provided by a Coriolis mass flowmeters.

10 Meter assembly 210 includes a pair of flanges 201 and 201' manifold 202 and conduits 203A and 203B. Driver 204, pick-off sensors 205 and 205', and temperature sensor 207 are connected to conduits 203A and 203B. Brace bars 206 and 206' serve to define the axis W and W' about which each conduit oscillates.

15 When Coriolis flowmeter 200 is inserted into a pipeline system (not shown) which carries the process material that is being measured, material enters flowmeter assembly 210 through flange 201, passes through manifold 202 where the material is directed to enter conduits 203A and 203B. The material then flows through conduits 203A and 203B and back into manifold 202 from where it exits meter assembly 210 through flange 201'.

20 Conduits 203A and 203B are selected and appropriately mounted to the manifold 202 so as to have substantially the same mass distribution, moments of inertia and elastic modules about bending axes W-W and W'-W', respectively. The conduits 203A-203B extend outwardly from the manifold in an essentially parallel fashion.

25 Conduits 203A-203B are driven by driver 204 in opposite directions about their respective bending axes W and W' and at what is termed the first out of phase bending mode of the flowmeter. Driver 204 may comprise any one of many well known arrangements, such as a magnet mounted to conduit 203A and an opposing coil mounted to conduit 203B and through which an alternating current is passed for vibrating both conduits. A suitable drive signal is applied by meter electronics 250 to driver 204 via path 212.

30 Pick-off sensors 205 and 205' are affixed to at least one of conduits 203A and 203B on opposing ends of the conduit to measure oscillation of the conduits. As the conduit 203A-203B vibrates, pick-off sensors 205-205' generate a first pick-off signal

and a second pick-off signal. The first and second pick-off signals are applied to paths 211 and 211'. The driver velocity signal is applied to path 212.

Temperature sensor 207 is affixed to at least one conduit 203A and/or 203B. Temperature sensor 207 measures the temperature of the conduit in order to modify equations for the temperature of the system. Path 211" carries temperature signals from temperature sensor 207 to meter electronics 250.

Meter electronics 250 receives the first and second pick-off signals appearing on paths 211 and 211', respectively. Meter electronics 250 processes the first and second velocity signals to compute the mass flow rate, the density, or other property of the material passing through flowmeter assembly 210. This computed information is applied by meter electronics 250 over path 275 to a utilization means (not shown). It is known to those skilled in the art that Coriolis flowmeter 200 is quite similar in structure to a vibrating tube densitometer. Vibrating tube densitometers also utilize a vibrating tube through which fluid flows or, in the case of a sample-type densitometer, within which fluid is held. Vibrating tube densitometers also employ a drive system for exciting the conduit to vibrate. Vibrating tube densitometers typically utilize only single feedback signal since a density measurement requires only the measurement of frequency and a phase measurement is not necessary. The descriptions of the present invention herein apply equally to vibrating tube densitometers.

In Coriolis flowmeter 200, the meter electronics 250 are physically divided into 2 components a host system 270 and a signal conditioner 260. In conventional meter electronics, these components are housed in one unit.

Signal conditioner 260 includes drive circuitry 263 and pick-off conditioning circuitry 261. One skilled in the art will recognize that in actuality drive circuitry 263 and pick-off conditioning circuitry 261 may be separate analog circuits or may be separate functions provided by a digital signal processor or other digital components. Drive circuitry 263 generates a drive signal and applies an alternating drive current to driver 204 via path 212 of path 220.

In actuality, path 212 is a first and a second lead. Drive circuitry 263 is communicatively connected to pick-off signal conditioning circuitry 261 via path 262. Path 262 allows drive circuitry to monitor the incoming pick-off signals to adjust the drive signal. Power to operate drive circuitry 263 and pick-off signal conditioning

circuitry 261 is supplied from host system 270 via a first wire 273 and a second wire 274. First wire 273 and second wire 274 may be a part of a conventional 2-wire, 4-wire cable, or a portion of a multi-pair cable.

Pick-off signal conditioning circuitry 261 receives input signals from first pick-off  
5 205, second pick-off 205', and temperature sensor 207 via paths 211, 211' and 211". Pick-off circuitry 261 determines the frequency of the pick-off signals and may also determine properties of a material flowing through conduits 203A-203B. After the frequency of the input signals from pick-off sensors 205-205' and properties of the material are determined, parameter signals carrying this information are generated  
10 and transmitted to a secondary processing unit 271 in host system 270 via path 276. In a preferred embodiment, path 276 includes 2 leads. However, one skilled in the art will recognize that path 276 may be carried over first wire 273 and second wire 274 or over any other number of wires.

Host system 270 includes a power supply 272 and processing system 271.  
15 Power supply 272 receives electricity from a source and converts the received electricity to the proper power needed by the system. Power supply 272 may incorporate power supply circuit 100 (FIG. 1) in accordance with this invention to provide DC current of a desire voltage to flowmeter 200 regardless of whether the input current is AC or DC and the voltage of the input current. Processing system 271  
20 receives the parameter signals from pick-off signal conditioning circuitry 261 and then may perform processes needed to provide properties of the material flowing through conduits 203A-203B needed by a user. Such properties may include but are not limited to density, mass flow rate, and volumetric flow rate.



**What is claimed is:**

1. A circuit (100) for supplying a DC output of a desired voltage regardless of the power received comprising:
  - a rectifier (101) that converts an alternating current (AC) input to direct current (DC) and changes a DC input to a desired polarity;
  - 5 a boost converter (110) that receives DC current having a first voltage from said rectifier and outputs current having at least a minimal voltage; and
  - a buck boost convertor (120) that receives said DC current having said at least said minimal voltage and outputs a current having a desired voltage.
2. The circuit (100) of claim 1 further comprising:
  - a transformer (130) that provides a galvanic barrier between said buck booster (120) and a load.
3. The circuit (100) of claim 2 further comprising:
  - an output rectifier (140) that prevents excess current from said circuit.
4. The circuit of claim 3 further comprising:
  - an opto-coupled feedback (142) that is connected to said output rectifier (140);
  - and
  - a buck boost feedback control (123) that regulates current output from said
  - 5 buck-booster converter.
5. The circuit of claim 1 further comprising:
  - control circuitry (115) that maintains said at least minimal output voltage of current output by said boost converter.
6. The circuit of claim 5 further comprising:
  - start-up circuitry (105) regulates voltage applied to said control circuitry (115).
7. The circuit of claim 1 wherein said circuit is a power supply for meter electronics of a Coriolis flowmeter.

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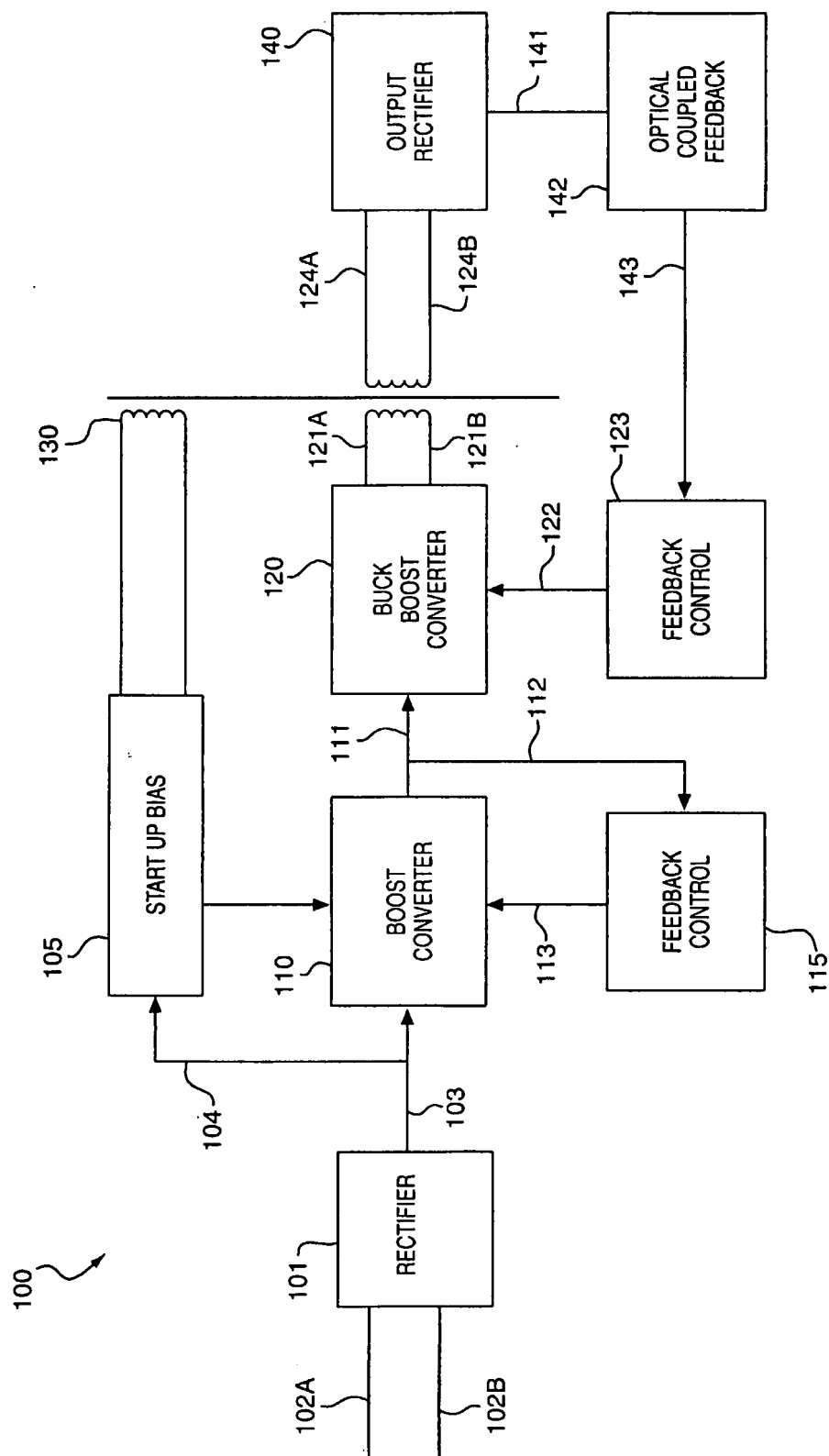
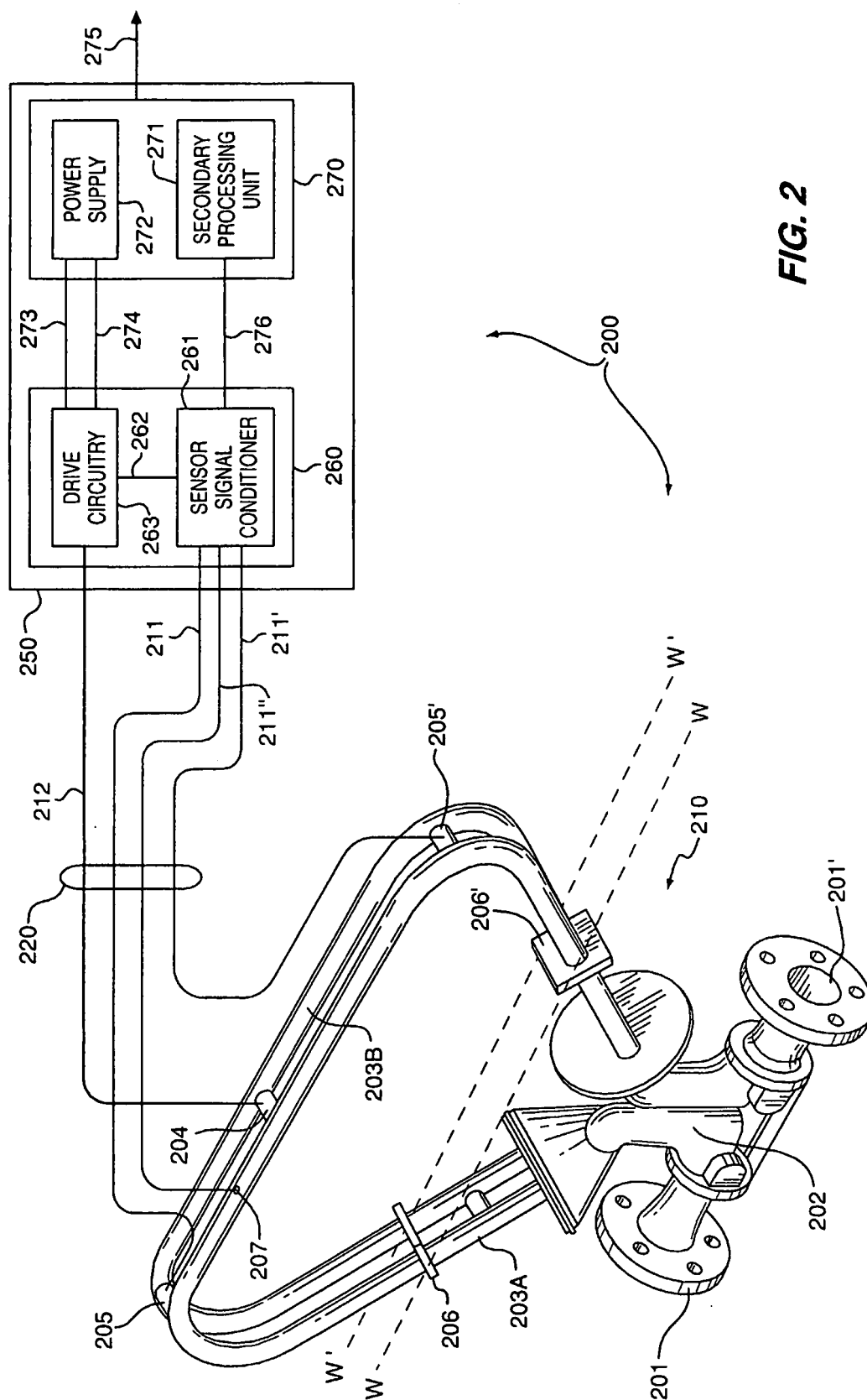


FIG. 1



**FIG. 2**